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ABSTRACT

The purposes of this study were: (1) to identify
those attitudes toward mathematics courses at selected institutions;
(2) to assess the relationship of those attitudes to selected
variables; and (3) to study the effect of those attitudes upon the
learning of mathematics in the selected courses. Data were collected
upon 420 freshmen in a university, a technical institution, and a
community college in the Midwest during the fall and winter of 1976.
The findings support those researchers who report predominately
negative attitudes toward mathematics among college students. There
were observable differences in the response patterns of students
according to sex and to type of institution. (Author/HM)

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Students' Attitudes Toward Mathematics and Their
Relationship to Learning in Required Mathematics
Courses in Selected Post-Secondary Institutions*

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Abstract

The purpose of the study was threefold: 1) to identify those attitudes toward mathematics that initially exist among college students in first-level required mathematics courses at selected institutions; 2) to assess the relationship of those attitudes to variables such as age, sex, and institutional type; and 3) to study the effect of those attitudes upon the learning of mathematics in the selected courses. Data were collected upon 420 freshmen in a university, a technical institution, and a community college in the Midwest during the Fall and Winter of 1976. The data included responses to Dutton's Mathematics Attitude Scale, mathematics pretest and posttest scores, demographic information, and math subscores of the ACT. Analyses revealed that a majority of the subjects (58%) held attitudes toward mathematics that were significantly negative ($p < .05$); that patterns of endorsement of attitude statements differed according to institutional subgroups; and that sex-differences in attitudes were significant, with males holding the more positive attitudes. Repeated correlations of attitude scores with measures of learning by sex, institutional type, and attitude level, while partialling out the ability variable, consistently yielded low, positive, relatively stable, but non-significant coefficients.

Introduction

The effect of attitudes upon teaching and learning is consistently mentioned in educational literature. Intuition suggests that the two are directly related. Interest in the relationship of math attitudes to math learning has motivated researchers to various kinds of inquiries, e.g., assessment and measurement of math attitudes, subject-preference research, correlational studies relating attitudes to subject and/or instructional variables, and development of programs to modify negative attitudes. The current research relating to math anxiety and its treatment may be considered a subset of the whole field of math attitudes research. While some researchers may contend that attitude, fear, and anxiety represent different constructs and warrant separate analyses, for the purposes of this study fear of mathematics and anxiety in its presence are treated as elements within the set of negative math attitudes.

Historically, researchers who have measured attitudes toward mathematics of college students--Dutton (1951), Poffenberger and Norton (1959), and Young (1932), to name a few--assert that their subjects held predominantly negative attitudes toward mathematics. Subject-preference research by Chase (1949) revealed that arithmetic was among the three most preferred subjects at the elementary level. Similar studies by Young (1932), however, found mathematics among the least preferred at the high school level and second only to physics as the field in which college students would never take another course. This

researcher's experiences as a classroom teacher, exchanges with colleagues, and readings in the field suggest that despite new instructional programs and techniques there exists to this day a dislike for and a wide-spread fear of mathematics ("mathemaphobia") among students, teachers, and the population in general.

The results of research measuring the effects of math attitudes on learning are inconclusive and, in some cases, seemingly contradictory. Harrington (1960) reported a statistically non-significant relationship between attitude and performance in college mathematics courses. Somewhat more substantial relationships between attitudes and achievement were obtained by Dreger and Aiken (1957). In their first study, they found a correlation of $-.44$ between the final grades of 704 students in a freshman mathematics course and their scores on a three-item inventory of anxiety in the presence of mathematics. In their second study, scores on the Math Attitude Scale developed by Aiken were found to contribute significantly to the final mathematics grades of 67 college women, but the attitudes were not a significant predictor for the 60 college men. An international study to assess mathematics achievement of 17-year-old students in a dozen countries found significant negative rank-order correlations between achievement and attitude across countries (Husen, 1967).

There are also differences of opinion among those currently involved in research into the causes and treatment of mathematics anxiety. There are those including Alice Shafer at Wellesley and Mitchell Lazarus

at the Educational Development Center, Newton, Massachusetts who believe the anxiety to be a function of academic deficiencies and to be best treated through instructional processes. Lazarus contends that "without a complete reeducation in mathematics, little can be accomplished in overcoming math anxiety" (1975). While others, such as Sheila Tobias at Wesleyan (1976), and Lucy Sells and John Ernest, University of California, (1977) think it to be related to demographic and societal factors and to be effectively treated through intervention experiences having both instructional and therapeutic components. An example of such treatment is the Math Anxiety Clinic opened at Wesleyan University by Sheila Tobias under an HEW grant from the Fund for the Improvement of Postsecondary Education. It is a place where people who are willing to acknowledge their problems with mathematics can admit themselves and be interviewed, tested, diagnosed, and helped in a variety of ways including both psychological counseling and tutoring in the subject matter.

Although researcher-writers support different points of view concerning causes, effects, and treatment of mathematics attitudes, they sound a common note in their recommendations for further research to determine the factors that influence students' math attitudes and to study the causal relationship between these attitudes and learning.

The purpose of this study, then, was threefold: 1) to identify those attitudes toward mathematics that initially exist among students in selected first-level required mathematics courses at the tertiary

level; 2) to assess the relationship of those attitudes to other subject variables such as sex, age, and institutional type; and 3) to study the effect of those attitudes upon learning in the selected courses.

Specifically, the study attempts to answer the following questions:

1. Do college students entering freshman-level required mathematics courses generally hold positive or negative attitudes toward the subject matter.
2. Are attitudes toward mathematics related to sex, age, or institutional type?
3. Do the initial attitudes affect the learning of mathematics in the respective courses?

In order to answer these questions, the researcher developed five null hypotheses to be tested:

1. The mean attitude score of the sample does not differ from the neutral position represented by the mean of the scale values of the items on the Attitude Scale.
2. The mean attitude scores of the institutional student groups do not differ from each other.
3. The individual attitude scores do not differ according to sex.
4. The individual attitude scores do not differ according to age.
5. There is no relationship between attitude score and measure of learning when ability is controlled.

Methodology

Sample

From the universe of students enrolled in first-level required mathematics courses in three types of post-secondary institutions--a state university, a technical institute, and a community college--a sample was selected that was accessible to the researcher and believed to be representative of these institutional types in the Midwest. The university component ($N = 96$) of the sample was comprised of students in three sections of Intermediate Algebra, Fall Semester, 1976, at Southern Illinois University. The technical institute group ($N = 242$) consisted of students in eight sections of Technical Mathematics, Fall Semester, 1976, in the School of Technical Careers, an associate degree granting unit within Southern Illinois University. The community college sample ($N = 82$) included students in three sections of Intermediate Algebra I at Richland Community College, Decatur, Illinois, during the Winter Quarter, 1976-77.

The composite sample ($N = 420$) comprised of the three institutional subgroups consisted of 320 males and 100 females. While the sexes were fairly equally represented in the university and community college groups, the males vastly outnumbered the females in the technical institute group. The preponderance of males is typical of the make-up of the student body in technical education programs. Weighting was used to compensate for unequal size of sample components when the composite group was involved in statistical analyses. A breakdown of

the sample according to sex and institutional type is given in Table 1.

TABLE 1
SAMPLE BY SEX AND INSTITUTION TYPE

Institution	Male	Female	Total
University	42	54	96
Technical Institute	236	6	242
Community College	42	40	82
Total	320	100	420

Instruments

The instruments used included Dutton's Mathematics Attitude Scale (1954) supplemented with biographical items and pretest and posttest forms for each of the mathematics courses used in the research. The scale consists of twenty-two statements which express attitudes toward different aspects of mathematics including both affective and cognitive factors. The statements which the subjects chose to endorse and/or not to endorse allowed the researcher to observe institutional response patterns as well as to compute individual attitude scores which reflected a general liking or dislike for the subject.

The items for the pretest and posttest forms for the university mathematics course were randomly selected from a bank of computer-stored items categorized by topic and by degree of difficulty. The parallel test forms for the technical institute and community college courses were prepared by the professors teaching the respective courses. The forms were validated by the panel-of-experts method using three members of the SIU mathematics faculty, all holding the Ph.D. degree in mathematics. They ascribed content validity declaring that the pretests and posttests were consistent with the stated course objectives and were comparable in difficulty.

Procedure

The attitude scale and the pretests were administered to all subjects during the first week of the term. Each instructor asked the students to participate in a research study involving attitudes and learning in mathematics. They were assured that they would not be identified in the study, and that their responses on the attitude scale and pretest in no way would affect their grades in the course.

During the term, the instructors proceeded to teach their courses in the usual manner, adhering rather strictly to the syllabus and scrupulously teaching the topics covered by the course objectives which had provided items for the pre- and posttests. At the end of the term, the posttest was given as a portion of the final examination to the 232 students who remained in the courses. Raw scores from the tests were converted to percentages since the number of test items varied from one course to another.

Demographic data including age, sex, and ACT math subscores were retrieved from the students' records with their written consent.

Information was coded into machine readable data and submitted to the computer using appropriate programs from the Statistical Package for the Social Sciences (SPSS) to compute additional measures, to analyze the data, and to test the hypotheses. Calculations yielded individual attitude scores (the mean of the scale values of endorsed statements) and measures of net learning gain (the difference in pretest and posttest scores). To avoid the ceiling effect of high pretest scores limiting the subjects' potential for gain, the ratio of net gain to potential gain was used as the measure of learning.

For example, a student scoring 10 out of a possible 100 points on the pretest and 50 on the posttest would have a net learning gain of 40 points while realizing $4/9$ or 44.4 percent of his potential for learning in the course. Another student scoring 50 on the pretest and 90 on the posttest would have an equal net learning gain of 40 points; however, he would have realized $4/5$ or 80.0 percent of his potential.

This corrective procedure was elected by the researcher as an appropriate adjustment of gain scores for the data analysis. More sophisticated methods of refining "raw gain" scores, e.g., residualizing change scores (Du Bois, 1957; Tucker, Damarin, and Messeck, 1966) or estimating true change by the use of complex formulas (Lord, 1963; McNemar, 1958) were not thought to be warranted by the quasi-representative design of the study. Furthermore, Cronbach believes that "when the

change measure is used as a criterion variable in a correlational study--the relationships involving true scores can be investigated without estimating true scores for individuals" (Cronbach, 1970).

Suspecting ability to be a confounding factor in the study of the attitude-learning relationship, the researcher thought it desirable to effect some control of the ability variable. The ability to succeed in any given mathematics course is largely dependent upon prerequisite knowledge in mathematics; and an acceptable measure of a college freshman's prerequisite math knowledge is the mathematics subscores (concepts, computation, composite) from the ACT test generally taken at the end of the eleventh year of school. The composite score which is the mean of the concepts and computation scores was used for the ability variable--meaning the ability to succeed in the given course rather than any implication of innate mathematical ability.

Results

Some indication of the kinds of math attitudes that are initially present in required courses was gained by observing the responses on the Attitude Scale by the composite group, the institutional subgroups, and the withdrawals as shown in Table 2. For analysis, the attitude statements were rearranged according to scale value, with the two neutral statements (11 and 12) in the central position. This arrangement allows the reader to infer attitudinal tendencies by inspection.

As a result of the weighting procedure provided by SPSS, the

TABLE 2

RESPONSES TO ATTITUDE SCALE BY TOTAL SAMPLE AND BY INSTITUTIONAL SUBGROUPS

Scale Value	Attitude Statement	Percent of Group Endorsing				
		Composite	University	Technical Institute	Community College	Withdrawals
1.0	1. I detest mathematics and avoid using it at all times.	3.5	7.3	2.1	1.2	3.9
1.5	2. I have never liked mathematics.	16.3	22.9	14.9	11.0	17.2
2.0	3. I am afraid of doing word problems.	34.7	47.9	28.1	28.0	31.3
2.5	4. I have always been afraid of mathematics.	24.8	31.3	19.8	23.2	26.6
3.0	5. I can't see much value in mathematics.	4.1	7.3	2.5	2.4	7.0
3.2	6. I avoid mathematics because I am not very good with figures.	15.7	20.8	14.0	12.2	20.3
3.3	7. Mathematics is something you have to do even though it is not enjoyable.	37.5	31.3	39.7	41.5	40.6
3.7	8. I don't feel sure of myself in mathematics.	53.5	58.3	54.5	47.6	57.0
4.6	9. I don't think mathematics is fun, but I always want to do well in it.	43.9	43.8	52.5	35.4	55.5
5.3	10. I am not enthusiastic about mathematics, but I have no real dislike for it either.	46.3	55.2	45.9	37.8	46.1
5.6	11. I like mathematics, but I like other subjects just as well.	37.8	31.3	34.7	47.6	32.8
5.9	12. Mathematics is as important as any other subject.	61.4	56.3	64.5	63.4	59.4
6.7	13. I enjoy doing problems when I know how to work them well.	65.0	66.7	68.6	59.8	62.5
7.0	14. Sometimes I enjoy the challenge presented by a mathematics problem.	53.2	54.2	50.4	54.9	43.8
7.7	15. I like mathematics because it is practical.	22.4	17.7	24.0	25.6	25.0
8.1	16. Mathematics is very interesting.	29.3	24.0	23.6	40.2	25.0
8.6	17. I enjoy seeing how rapidly and accurately I can work mathematics problems.	34.6	31.3	33.5	39.0	28.1
9.0	18. I would like to spend more time in school working mathematics.	13.7	10.4	16.1	14.6	17.2
9.5	19. I think about mathematics problems outside of school and like to work them out.	21.6	12.5	20.7	31.7	15.6
9.8	20. I never get tired of working with numbers.	8.6	8.3	7.9	9.8	12.5
10.4	21. I think mathematics is the most enjoyable subject I have taken.	1.1	0.0	2.1	1.2	2.3
10.5	22. Mathematics thrills me, and I like it better than any other subject.	1.4	1.0	0.8	2.4	0.8

composite group reflects equally the substrata which comprise it. Among all subgroups of the sample the items receiving the greatest endorsement ranged from item 7 (scale value 3.3) to item 14 (scale value 7.0). Relating this range to the median scale value, 5.75, or to the mean, 5.86, suggests negative skewness in the distribution. Two statements outside of the high-incidence range received an endorsement strong enough to warrant mention. The negative statement, "I am afraid of doing word problems" and the positive statement, "I enjoy seeing how rapidly and accurately I can work mathematics problems" each were endorsed by more than one third of the sample. When these statements are considered along with the modal statement, "I enjoy doing problems when I know how to work them well," one senses that a response message is forming.

A comparison of subgroup responses revealed some rather interesting differences. The university students gave the strongest support of all groups to the six most negative statements and generally weaker support for the positive statements. Sampling may have contributed to this negative tendency. Proficiency testing and/or advanced placement may have removed the mathematics and science majors from the university component. This speculation is reinforced by that group's support for "I avoid mathematics because I am not very good with figures" and lack of support for "Mathematics is something you have to do even though it is not enjoyable."

The response pattern of the technical institute students reveals an acceptance of mathematics for its utilitarian value rather than an appreciation for its aesthetic qualities. They supported more strongly than any other group "Mathematics is something you have to do even though it is not enjoyable", and "I don't think mathematics is fun, but I always want to do well in it." They gave the weakest support for "Mathematics thrills me, and I like it better than any other subject" and "Mathematics is very interesting." Their endorsements indicate that they view mathematics as a "means to an end." Their percentages were the lowest of all groups on the two items that spoke of fear, "I have always been afraid of mathematics," and "I am afraid of word problems." One possible explanation for this lack of fear is the preponderance of males in the technical institute sample. Perhaps "mathemaphobia" is more prevalent among females, as many researchers claim. Another logical reason is their constant application of mathematics to problems in the technical fields; and as they develop some degree of competency in the use of mathematics, they lose their anxiety in its presence. They also indicated a desire to "spend more time in school working mathematics problems."

The frequency distribution of the community college students' responses appears to approach more nearly a normal distribution and the central high-incidence range suggests a more neutral attitude toward the subject of mathematics. The percentages of students

believing mathematics to be interesting (statement 16) and thinking about mathematics problems outside of school (statement 19) were much higher for this group. It is possible that the community college component included student types who were eliminated from the other institutional samples. Students in the college-transfer program who plan to continue in the mathematics and/or science fields may have held the more positive attitudes which altered the group's response pattern. On the other hand, the community college's alleged emphasis on teaching, its sensitivity to students' needs, smaller classes, and smaller student-teacher ratios may have combined to produce more favorable attitudes toward mathematics.

The group designated as withdrawals includes all of the subjects who failed to take the mathematics posttest ($N = 128$). Since the withdrawals had not been proposed originally as a subgroup of the study, nor was any hypothesis relating to them stated, the researcher did not include this group in any analyses beyond a cursory observation of their responses. Their relatively strong endorsement for the statements, "I have always been afraid of mathematics," and "I avoid mathematics because I am not good with figures," may explain the withdrawal classification.

Testing the Hypotheses

Hypothesis One: The mean attitude score of the population does not differ significantly from the neutral position represented by the mean of the scale values of the attitude statements.

The difference between the weighted group attitude-mean of the total sample (5.56) and the scale mean (5.86) was tested for significance using Student's *t*. The negative difference was significant well beyond the acceptable level ($p < .001$). The same test using the unweighted group means also yielded a significant difference. Therefore, the null hypothesis was found to be untenable and rejected.

Hypothesis Two: The mean attitude scores of the institutional student groups do not differ significantly from each other.

($\chi^2 = 4.64$, $p < 0.10$)

A 2 x 3, attitude-by-institutional-type matrix was produced by the CROSSTABS procedure with the results shown in Table 3.

TABLE 3
MEAN ATTITUDE SCORES BY INSTITUTIONAL GROUP^a

Group	Negative (below scale mean)	Positive (above scale mean)	Total
University (N)	62	34	96
(Row $\bar{X}$)	64.6	35.4	22.9
(Column $\bar{X}$)	26.3	18.5	
(% of Total)	14.8	8.1	
Technical Institute (N)	134	108	242
(Row $\bar{X}$)	55.4	44.6	57.6
(Column $\bar{X}$)	56.8	58.7	
(% of Total)	31.9	25.7	
Community College (N)	40	42	82
(Row $\bar{X}$)	48.8	51.2	19.5
(Column $\bar{X}$)	16.9	22.8	
(% of Total)	9.5	10.0	
Column Total (N)	236	184	420
($\bar{X}$)	56.2	43.8	100.0

^aChi square = 4.64189 with 2 degrees of freedom; significance = 0.0982.

Although an inspection of the cell values suggests some apparent differences among groups, these differences were not found to be significant at the required level by the chi square test. The null hypothesis was not rejected.

Hypothesis Three: The individual attitude scores do not differ significantly according to sex.

This hypothesis was also analyzed by a matrix (attitude-by-sex) and tested by chi square as displayed in Table 4.

TABLE 4
MEAN ATTITUDE SCORES BY SEX^a

Sex	Negative (below scale mean)	Positive (above scale mean)	Total
Female (N)	66	34	100
(Row %)	66.0	34.0	23.8
(Column %)	28.0	18.5	
(% of Total)	15.7	8.1	
Male (N)	170	150	320
(Row %)	53.1	46.9	76.2
(Column %)	72.0	81.5	
(% of Total)	40.5	35.7	
Column Total (N)	346	184	420
(%)	56.2	43.8	100.0

^aChi square = 4.62086 with 1 degree of freedom; significance = 0.0316.

Observation of the cell values shows that, while a majority of both females and males held negative attitudes, the percentage of females with negative attitudes was much greater. The difference was

statistically significant ($p < .03$); the null hypothesis was rejected.

Sex differences in math attitudes are further substantiated by a tabular representation of responses to the Attitude Scale by sexes (Table 5).

Insert Table 5 here

It is interesting to note that both statements which use the word "afraid" (3 and 4) were more strongly endorsed by females. This observation supports the findings of Tobias (1976), Aiken (1976), and Szetela (1973), to name a few, who have reported that mathematics anxiety disproportionately affects females. The strong support females gave to statement 6, "I avoid mathematics because I am not good with figures," is consistent with Fox's finding that ". . . when mathematics courses become optional, far fewer females elect to take them" (1975, p. 350). Sherman and Fennema state that, "Failure of females to enroll as often in mathematics classes as boys appears to be associated with lesser confidence" (1977). Statements 7 and 15, which relate to the student's perception of the usefulness of mathematics, received a significantly lower response from the females. Anastasi (1974) suggests that there is evidence that girls tend to avoid mathematics courses partly because they do not perceive such training as relevant to their career goals.

TABLE 5
RESPONSES TO ATTITUDE SCALE BY SEXES

Attitude Statement	Males (%)	Females (%)
1. I detest mathematics and avoid using it at all times.	2.2	6.0
2. I have never liked mathematics.	15.6	17.0
3. I am afraid of doing word problems.	26.6	52.0
4. I have always been afraid of mathematics.	20.9	30.0
5. I can't see much value in mathematics.	3.7	3.0
6. I avoid mathematics because I am not very good with figures.	12.7	22.0
7. Mathematics is something you have to do even though it is not enjoyable.	40.9	29.0
8. I don't feel sure of myself in mathematics.	52.2	60.0
9. I don't think mathematics is fun, but I always want to do well in it.	50.9	35.0
10. I am not enthusiastic about mathematics, but I have no real dislike for it either.	47.9	45.0
11. I like mathematics, but I like other subjects just as well.	35.6	39.0
12. Mathematics is as important as any other subject.	62.8	61.0
13. I enjoy doing problems when I know how to work them well.	65.6	69.0
14. Sometimes I enjoy the challenge presented by a mathematics problem.	51.6	54.0
15. I like mathematics because it is practical.	25.0	16.0
16. Mathematics is very interesting.	26.2	29.0
17. I enjoy seeing how rapidly and accurately I can work mathematics problems.	35.0	31.0
18. I would like to spend more time in school working mathematics.	15.0	13.0
19. I think about mathematics problems outside of school and like to work them out.	22.8	15.0
20. I never get tired of working with numbers.	8.4	8.0
21. I think mathematics is the most enjoyable subject I have taken.	1.6	1.0
22. Mathematics thrills me, and I like it better than any other subject.	1.2	1.0

Hypothesis Four: The individual attitude scores do not differ according to age. The subjects were separated into two age groups: 1) those under 23 years of age which should include the students in the regular "college-age" group, and 2) those 23 years of age and older, which should include the adult learners and/or those who have interrupted the regular educational sequence for some reason. The difference in means of the two groups (23 and over, 5.85; under 23, 5.51) was found to be significant ($p < .05$). A correlational analysis of the relationship between attitude and age also yielded a positive relationship significant beyond the .05 level for this sample. Consequently, the null hypothesis was rejected.

Hypothesis Five: There is no significant relationship between attitude scores and measures of learning when the ability variable was controlled.

Preliminary analyses relating attitude score to ability, and learning to ability yielded positive coefficients of correlation that were significant beyond the .001 level in both cases. Therefore, it was appropriate to consider ability as defined in this study a confounding factor and to control that variable while studying the relationship between attitude and learning. The coefficient of partial correlation between attitude and learning, controlling for ability ($r = .10$) was found to be non-significant ($p < .08$). Further analyses by sex and by attitude levels which had been recommended by other researchers failed to yield a significant relationship between attitude and learning. Therefore, the null hypothesis was not rejected.

Although the coefficients were not significant at the required level, they were consistently positive and relatively stable in value ($p \approx .09$).

Discussion

The finding that a majority of the college students studied, approximately 58 percent, held predominantly negative attitudes toward mathematics is consistent with those of Dutton (1954), Poffenberger and Norton (1959), Aiken (1970), and others who have reported generally negative attitudes among samples of college students. The results suggest that this fear of and/or dislike for mathematics is not peculiar to the students in any particular type of post-secondary institution, but is rather an attitude commonly shared by students in various types of post-secondary institutions. Further findings suggest, however, that these negative attitudes may affect the learning of mathematics only indirectly. The non-significant results of the partial correlation analysis, controlling for ability, tend to support those who claim the learning of mathematics more likely to be a function of ability than of attitude. Nevertheless, the indications that negative attitudes contribute to math avoidance and failure to persevere when once enrolled (withdrawals) cannot be ignored as attitudinal factors indirectly affecting the learning process.

The significant sex-differences in attitudes reinforce the position Aiken states in his 1976 update on attitude research, ". . . more frequently differences in mathematics are found to favor

boys over girls at the junior high level and beyond (Hilton and Berglund, 1974; Keeves, 1973; Nevin, 1973; Simpson, 1974)." There were characteristic sex differences noted in the responses to the attitude statements that support the claims of other researchers: evidence of greater mathematics anxiety among females (Tobias, Stent); a stronger tendency by females to avoid mathematics (Fox, Sherman, and Fennema); perception of mathematics by females as less useful and less relevant to career goals (Anastasi, Sells).

A rather unexpected finding of the study was the significant positive relationship of attitudes to age. The bulk of research seems to indicate contrariwise that attitudes toward mathematics become increasingly negative as students ascend the academic ladder from elementary school to college (Aiken, p. 556). It is likely that the result in this study reflects a special phenomenon of the age groups included. It seems to suggest that among college students those beyond the traditional "college age" have significantly positive attitudes toward mathematics. A positive attitude toward learning in general may have motivated their return to formal education and may characterize their outlook on the whole process.

The results of this study along with the conclusions of similar studies of college students have implications in the field of mathematics education and for further research on the topic. The indication that a majority of college students in required mathematics courses hold negative attitudes toward the subject matter which may be

directly related to academic deficiencies implies careful selection of teachers for such courses. An awareness of the dynamic interaction of both cognitive and affective factors which may be affecting the learning experience suggests that a teacher with "all the tools," a thorough knowledge of mathematics, an enthusiasm for the subject, the ability to give lucid, comprehensible explanations and to make meaningful applications, and a genuine concern for individual students' academic and emotional needs should be the one selected to teach the mainstream mathematics courses. The teacher education program for prospective mathematics teachers should prepare them to expect, recognize, and deal with negative attitudes toward mathematics and to plan positive learning experiences for those students who exhibit them.

Further research is needed to determine causal relationships among the interacting variables, to identify the sources of negative attitudes, and to discover and provide positive learning experiences for math-anxious students.

For: Dr. H. L. Loefer and the University of
South Carolina and

between attitudes and
course

New York

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